RF Amplifier System with Interface to Provide a Computer Readable Spectral Depiction of the RF Output

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/362,295, filed March 6, 2002 and of U.S. Provisional Application No. 60/362,503, filed March 6, 2002.

BACKGROUND OF THE INVENTION

[0002] RF amplifier systems may be used to amplify radio frequency (RF) signals for over the air broadcasting. RF amplifier systems are used at cellular telephone sites which may be in remote locations. It may be necessary to monitor the output of an RF amplifier system to ensure that it is performing properly and in compliance with applicable broadcasting regulations. It may be very costly to dispatch a technician to a remote site for routine testing. Even if the site of the RF amplifier system is convenient, it is costly and time consuming to dispatch a technician with the necessary skills to correctly test the output of an RF amplifier system. These limitations may cause the RF amplifier system to operate improperly or out of compliance for a substantial period of time until a technician visits the site of the RF amplifier system to monitor the output of the system.

SUMMARY OF THE INVENTION

[0003] An RF amplifier system includes an RF power amplifier, a coupler, a digital signal analysis circuit, and an interface. The RF power amplifier has an RF output. The coupler is coupled to the RF power amplifier to detect the RF output. The digital signal analysis circuit is coupled to the coupler to produce a digital signal that provides a spectral depiction of the RF output. The interface is coupled to the digital signal analysis circuit to provide the spectral depiction of the RF output to an attached computer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. 1 is a block circuit diagram of an exemplary RF amplifier system that embodies the present invention.

[0005] FIG. 2 is a block circuit diagram of another exemplary RF amplifier system that embodies the present invention.

[0006] FIG. 3 is a block circuit diagram of an exemplary digital signal analysis circuit that may be used in an embodiment of the present invention.

[0007] FIG. 4 is a block circuit diagram of another exemplary digital signal analysis circuit that may be used in an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0008] Figure 1 shows an RF amplifier system 10 that embodies the present invention. The RF amplifier system 10 receives an RF input 12 and produces an RF output 16 that is the result of amplifying the RF input with an RF power amplifier 14. A coupler 18 detects the output 16 of the RF power amplifier 14 and feeds the detected signal into a digital analysis circuit 20 that produces a digital analysis of the spectral output of the RF power amplifier 14.

[0009] The digital analysis produced by the digital analysis circuit 20 is then converted by a computer interface 22 to a form that can be read by a computer connected to the interface output 24. The computer may display or print an X vs. Y plot of the output of the digital signal analysis circuitry to provide a spectral depiction of the output of the RF power amplifier 14. By integrating the RF power amplifier 14, the coupler 18, the digital analysis circuit 20, and the computer interface 22 in the single chassis of the RF amplifier system 10, the proper selection of coupler and analysis circuit for the RF power amplifier and the proper connection is assured. This may allow maintenance and servicing of the RF amplifier system 10 more quickly and by technicians with a lower skill requirement.

[0010] Figure 2 shows another RF amplifier system 11 that embodies the present invention. In this embodiment the digital analysis produced by the digital analysis circuit 20 is converted by an Internet Protocol (IP) interface 26 to a form that can be communicated over long distances on the internet by coupling the interface output 28 to the internet. A remotely located computer

may access the RF amplifier system 11 using an internet connection to read, display, or print a spectral depiction of the output of that RF power amplifier 14. This may allow the operation of the RF amplifier system 11 to be monitored for correct operation without the need to send a technician to the site of the RF amplifier system on a routine basis. Remote monitoring may allow an initial diagnosis of detected faults so that a properly equipped technician can be dispatched to effect a repair of the RF amplifier system 11. A single RF amplifier system may include both the computer interface 22 and the IP interface 26 and provide both the computer interface output 24 for local service and the IP interface output 28 for remote monitoring.

[0011] Figure 3 shows an exemplary embodiment of the digital analysis circuit 20. The detected signal 30 from the coupler 18 (Figures 1 and 2) is mixed down in frequency via a voltage controlled oscillator (VCO) 32, a mixer 34, and a filter 36. A ramp generator 38 feeds the VCO 32 with a varying voltage. The output of the filter 36 is coupled to a log detector 40.

[0012] The resulting analog output of the log detector 40 is digitally converted via a low speed, low cost analog-to-digital (A/D) converter 42 to provide a "Y" (magnitude) portion of an output signal 44a. The analog DC voltage output of the ramp generator 18 that is provided to the VCO 32 is also converted via a second low speed, low cost, A/D converter 46 to provide an "X" (frequency) portion of the output signal 44b. An X vs. Y plot of the output signal 44 from the digital analysis circuit 20, via electrical or mechanical means, may result in a spectral depiction of the RF output 16 of the RF amplifier system.

[0013] Figure 4 shows another exemplary embodiment of the digital analysis circuit 20. In this embodiment, the detected signal 30 from the coupler 18 is mixed down with the signal from the VCO 32 as in the previous embodiment. A microprocessor 48 or controller instructs the ramp generator 38' to additionally output a blanking or "0" signal 50 of a known interval simultaneously with the zero VDC point of the signal from the ramp generator 38'. The blanking signal 50 is fed into the output of the log detector 40. The resulting analog output of the log detector 40 is digitally converted via a low speed, low cost A/D converter 42 to become the "Y" (magnitude+time) output signal 44. The blanking signal contained within the Y (magnitude+time) output may then be

extracted and used to represent the flow of the X (time) portion of an X vs. Y plot that is a spectral depiction of the RF output 16 of the RF amplifier system.

[0014] An RF amplifier system 10 that embodies the present invention may permit local or remote monitoring of the RF output for overall or per-channel power output, spurious signals or other forms of distortion, or to check any other performance parameter where the information is contained within the spectral depiction. The invention may further permit local or remote monitoring of the RF output of a cellular telephone site for conformance to power output, emissions mask specifications, or to check any other performance parameter where the information is contained with the spectral depiction.

[0015] While certain exemplary embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention, and that this invention not be limited to the specific constructions and arrangements shown and described, since various other modifications may occur to those ordinarily skilled in the art.